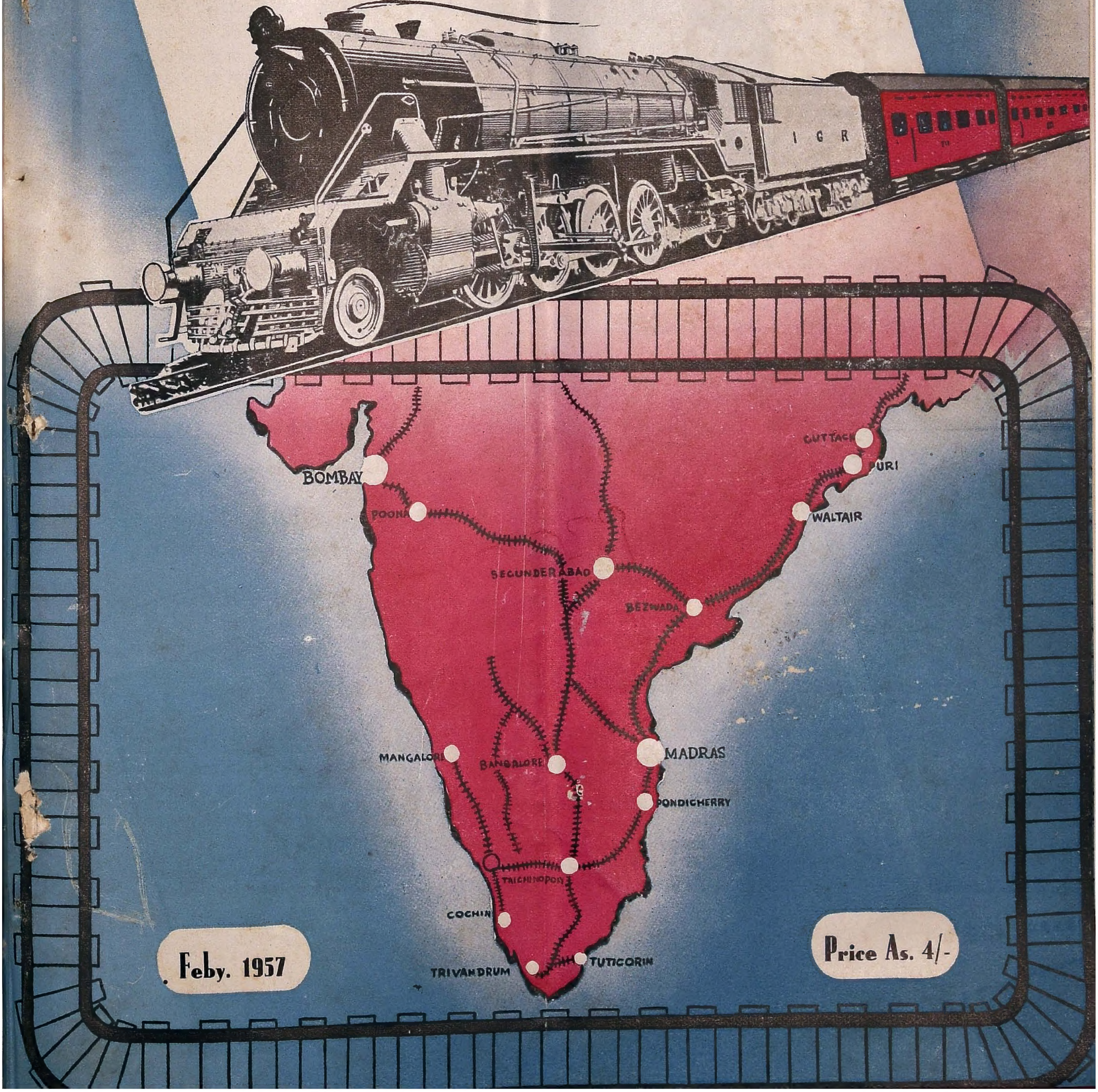
SOUTHERN RAILWAYS *Magazine*



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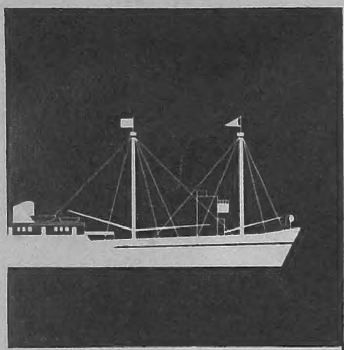

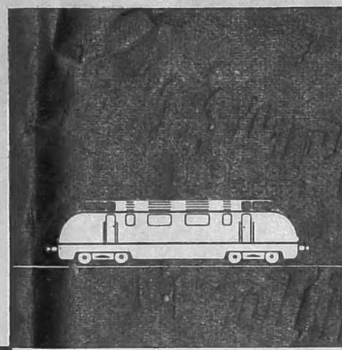

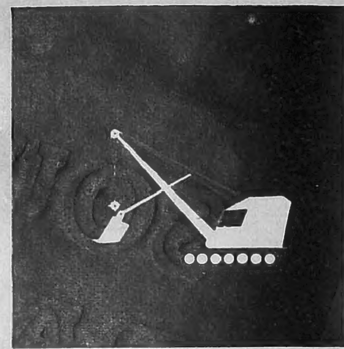

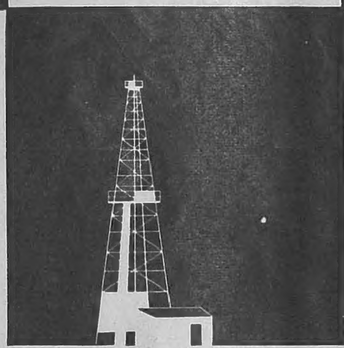

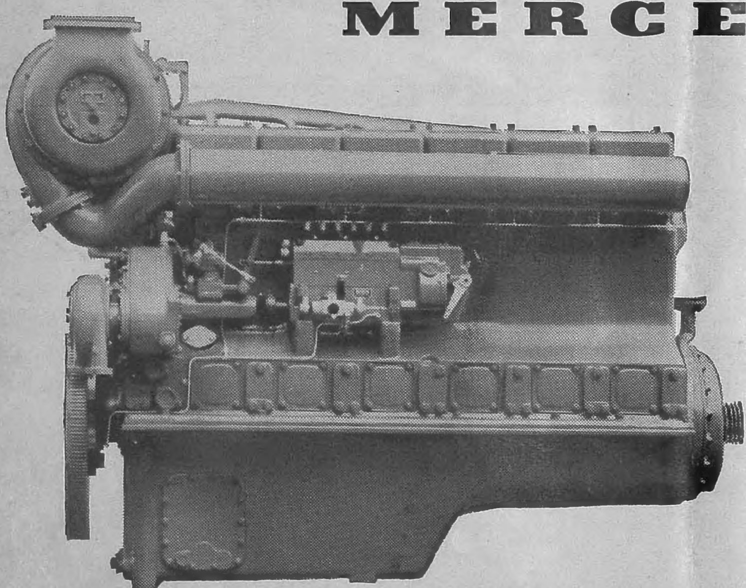

National Metallurgical Laboratory

NATIONAL Metallurgical Laboratory in its six years of active life has established its place and have conducted a number of research projects which have paved the way of valuable improvement and additions to India's metallurgical industries. The research work of the laboratory is carried out in the following seven divisions.

1. General Metallurgy
2. Chemical
3. Ore-dressing and Mineral Beneficiation
4. Refractories
5. Physical Metallurgy
6. Mechanical Metallurgy & Testing
7. Extractive Metallurgy.

Pioneering work has been done in this laboratory on Indian moulding sands and a large variety of indigenous foundry sands from various localities have been investigated and their suitability for use in non-ferrous, cast iron and steel foundries have been determined. A side-line attention has been given to the 'bonding clays' such as bentonite, used in preparing synthetic sands.

Cast iron can be made ductile by a process known as nodularising and this nodular cast iron—as it is called—can be substituted for a number of steel products. Extensive work has been done on the production of nodular cast iron and determining the suitability of Indian pig iron for its manufacture. The theoretical aspect of the problem has also been dealt with and an explanation has been offered on the mechanism of formation of graphite spherulite which has been highly appreciated in U. K. & U. S. A.

Alloys of aluminium and silicon are widely used in engineering and automobile industries. The existing methods of preparing aluminium-silicon alloys are expensive under Indian conditions. A new method of production of aluminium-silicon alloy by alumino-thermic reduction of quartz has been successfully developed which will be particularly advantageous under the existing Indian raw material conditions.

A process has been developed whereby steel materials can be coated with a layer of aluminium which can be used in place of galvanized steel. Utilisation of this process would enable to cut down the import of zinc and is advantageous from the view point that resources of aluminium are plenty in this country.

With the object of promoting the growth of alloy-steel industry and utilizing the available raw materials of the country, a research project has been undertaken to find out the possibility of developing chromium-manganese-nickel stainless steels similar in properties to the well known 18/8 variety. The main aim is to conserve nickel (which has to be imported due to the absence of suitable economic deposits) and to utilise manganese for which abundant resources are available. Investigations on the possibilities of production of ferro-alloys which are also vitally important towards the establishment of alloy steel industries in the country, have been undertaken.

Experiments have been conducted on the cottage industry production of steel by direct reduction of iron ore with charcoal. The process is particularly suitable for utilising iron ore fine, huge dumps of which have already accumulated in our country. This method will yield blooms weighing a few pounds that can be worked down by blacksmiths. Much progress has been made towards the preparation of self-lubricating bronze bearings by powder metallurgy techniques. Successful conclusion of the project would be of great assistance to the Indian electric fan manufacturers.

India is placed in a fortunate position in regard to the deposits of ilmenite—an ore of titanium. Till recently ilmenite was mainly used in the titanium paint industry.

Recent developments, however, have given great importance to the metallurgy of titanium and the use of metallic titanium as an engineering and structural material. Titanium metal has already been prepared in this laboratory on a small scale and alternative cheaper methods of preparation are under investigation.

The problem of preventing the national waste of low-grade manganese ores is having its due considerations in this laboratory. Electrolytic manganese metal over 99.75% purity has been produced on a laboratory scale from low as well as high grade manganese ores, production of which on semi-pilot plant scale has given equally encouraging results. This electrolytic manganese can be used as a substitute for high grade ferro-manganese as well as for making some non-ferrous alloys. Production of high-purity manganese dioxide suitable for use in batteries has been investigated and a process to this extent has been developed.

The problems of plating industry found extensive scopes at the National Metallurgical Laboratory. Several plating problems relating to plating industry have been completed. The substitution of cyanide baths which are dangerous to work with, by those of non-cyanide solutions for the electro-plating of brass, has been successfully developed. Commercial application of this method is understudy. Technique of plating metals on non-metals like glass, wood, porcelain, has been evolved. Experiments on a laboratory scale for plating nickel and chromium on aluminium have proved extremely successful. This problem should be of special interest to automotive industry, as it combines the advantages of light weight of aluminium with the wear and corrosion resistant surface of chromium.

Under the scheme 'Protection of Metals' research work is being carried out on various corrosion problems and methods of preventing corrosion. Protection by plating, inorganic surface coating, painting and metal spraying are being tried.

Utilisation of the country's low-grade ore-deposits is receiving constant attention of the laboratory. A large varieties of low-grade manganese ore-deposits from all over the country have been beneficiated and their suitability for the manufacture of standard grade of ferro-manganese have been determined. A large number low-grade chromites have also been investigated and their suitabilities for use in metallurgical, refractory and chemical industries have been investigated.

Successful investigations have been conducted on a number of pyrite ores from which sulphur or sulphur bearing minerals were economically concentrated to a marketable grade which can be subsequently used for the manufacture of sulphuric acid.

For the development of atomic energy, beneficiation work has been undertaken on a large number of low-grade radio active ores so as to produce a suitable concentrate for the extraction of uranium.

In connection with the establishment of steel plant at Bhilai, experiments on sintering of iron ore fines were carried out in this laboratory and successful sinter has been produced for the first time in this country.

Development of quality refractory materials from indigenous resources is actively pursued in this laboratory. In accordance with it high temperature refractory with mullite as the main constituent has been produced from Travancore beach sand sillimanite. Hot face insulating bricks have also been successfully made from bladed kyanite.

The use of carbon refractories is well established in the field of electro-metallurgical industries. It has been found possible of produce carbon blocks of suitable quality for the cathode linings for aluminium cells as well as for lining blast furnaces. Full size bricks which were prepared were found to be in no way inferior to foreign brands.

Forsterite refractories are finding extensive uses in metallurgical industries and may be substituted for magnesite refractories on certain cases. Forsterite refractories having high spalling resistance have been developed in the laboratory using indigenous raw materials.

A carbon bonded graphite crucible with satisfactory physical properties and good resistance to oxidation has been arrived at in the course of investigation on the possibility of graphite crucible manufacture from indigenous graphite and clays.

A comprehensive study of Indian fireclays has shown that some of them could be used for the manufacture of firebricks having a refractoriness under load value of 1500°C or above. This quality of firebricks which would be required according to Russian specification for the Bhilai Steel Plant, is not being made in this country at present. Commercial exploitation of these clays on scientific lines should meet the entire requirement of the Bhilai Steel Plant.

Encouraging results have been obtained on development of a new heat resistant alloy based on iron,

manganese and aluminium. Investigation on controlled friction material and determination of fatigue resistance of structural steels have made considerable progress. Study of wear resistance of railway wheels, tyres and rails has produced encouraging results. Production of iron using non-coking coal is under active consideration of the laboratory.

Apart from the above applied researches a number of fundamental problems on different aspects of metallurgical science have been undertaken, work on some of which have brought commendable remarks from foreign countries. Holding of symposia on important metallurgical subjects form a regular feature of the laboratory. Such symposia bring together the scientists and industrialists on a common platform where the various technical aspects of the subject matter are discussed. The following five symposia have been held so far which were highly successful from all angles.

1. Electroplating and metal finishing.
2. Industrial Failures of Engineering Metals & Alloys.
3. Non-ferrous metal industry in India.
4. Recent trends in the field of production, practice and research on refractories used in metal industry.
5. Production, properties and applications of alloy and special steels.

In addition to the research work, one of the important activities of National Metallurgical Laboratory relates to the education and development of the country's metallurgical industries by supplying them proper technical information and guidance and undertaking problems on their behalf. Already a large number of private industries and government bodies have been benefited by the technical information service operated by the Liaison & Information section of the Laboratory.

Catering to the demand of Indian metallurgical industries and the public forms an essential function of the National Metallurgical Laboratory. Contact with industries and public bodies is maintained by the Liaison and Information Section with a view to ascertain the type of work required of laboratory so as to plan its activities and to clarify and popularise the aims and results of the research, thereby, rendering as much aid to industrial development of the country. The open door policy of National Metallurgical Laboratory to guests and visitors is another way in which the Laboratory keeps in touch with the public. The results of the research work carried out are mostly published in Journal of Scientific & Industrial Research, New Delhi, "Research & Industry," publications Division C.S.I.R., Old Mill Road, New Delhi, and in the proceedings and transactions of learned societies and institutes.

The work of National Metallurgical Laboratory is continuing and expanding. A number of pilot plants have been set up and more are coming up to facilitate experimental trials of research projects on a semi-commercial scale. Research results thus nourished in the laboratory are translated into industrial production. In the industrialisation programme of our country under the impetus of Second Five year Plan the National Metallurgical Laboratory is playing and will continue to play a vital role towards the development and establishment of metallurgical industries.

SUPPLIES FOR BHILLAI PLANT

It is reported that structural steel for the openhearth shop of Bhillai Steel Plant have been shipped from Soviet Russia. The main structures of two big capacity all welded blast furnaces have already been manufactured and are now being equipped with up-to-date automatic devices and mechanisms for smelting under increased gas pressure. Assembly work has already been completed on basic structures for two 250-ton openhearth furnaces, a foundry shop and a bunkering trestle. It may be mentioned that so far about fifteen hundred trainloads of plants and machinery have been shipped since the beginning of 1956 for the Steel plant at Bhillai.

HYDRAULIC POWER TRANSMISSION FOR RAIL VEHICLES

By KUGEL,

Director, J. M. VOITH, G. M. B. H., Heidenheim, Germany.

WITH respect to hydraulic transmissions it must be differentiated between hydrostatic and hydrodynamic power transmissions. In the case of hydrostatic power transmission the static pressure is used, while with the hydrodynamic system the forces are put to use resulting from the acceleration or deceleration of a fluid in movement. So far the hydrostatic system has not found a major application as drive of vehicles. Therefore only the hydrodynamic or hydrokinetic fluid power transmission system will be considered.

Fig. 2698 shows the basic arrangement of a hydrodynamic power transmission. At this stage, the schematic drawing in the center of this illustration is to be disregarded. With the arrangement as shown in fig. 2698, by way of example, a Diesel engine is assumed to drive a centrifugal pump, which from a reservoir draws and accelerates a fluid. This calls for a torque which must be furnished by the engine. According to the law of Newton, by virtue of which force is equal to mass times acceleration, the mass in constituted by the volume of fluid in liters per second passing through the pump.

The fluid through a pipe is channeled to a turbine in which the fluid is decelerated, so that in return a torque is set up, which in the case under consideration is used to drive a screw propeller of a ship.

If for this transmission arrangement the efficiencies of the pump and the turbine are assumed to be each 0.85, and if the friction losses in the piping and in the reservoir are considered, the total efficiency will be at

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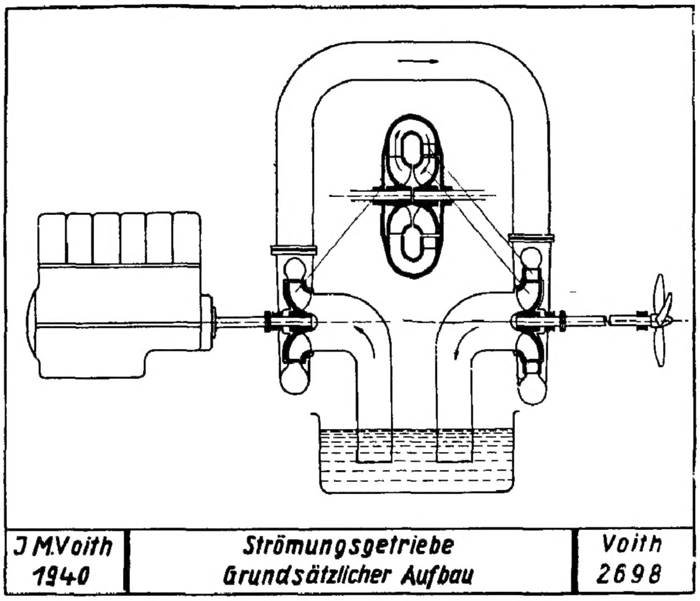
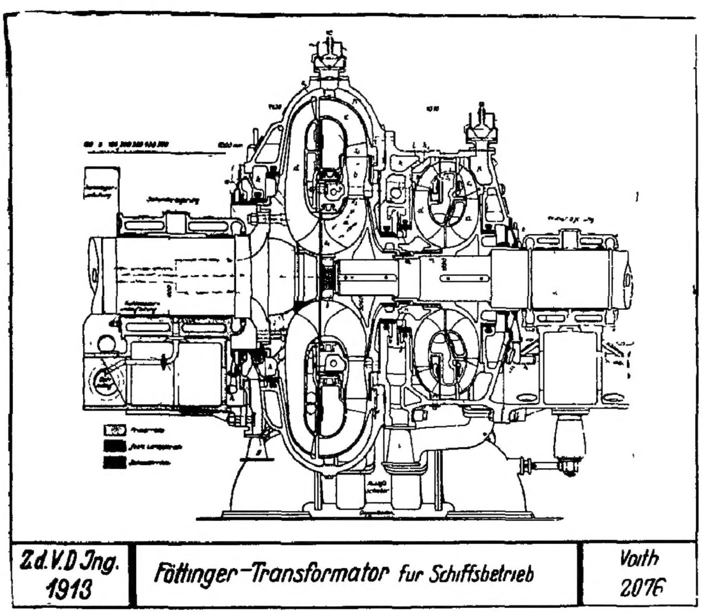


Principle of hydrodynamic power transmission.

best 0.6, which for practical purposes would be too uneconomical. Furthermore, this drawback of low overall efficiency is aggravated by high weights and considerable initial costs.

This was the state of affairs when in 1905 the German engineer Foettinger came out with his invention, which—as shown in the center of this illustration—combined centrifugal pump and turbine in a closed circuit dispensing with all spiral cases, bends and piping and their inherent losses. It was by this invention that the hydrodynamic transmission has become an extremely useful and suitable equipment with respect to efficiency, space requirements and weights.

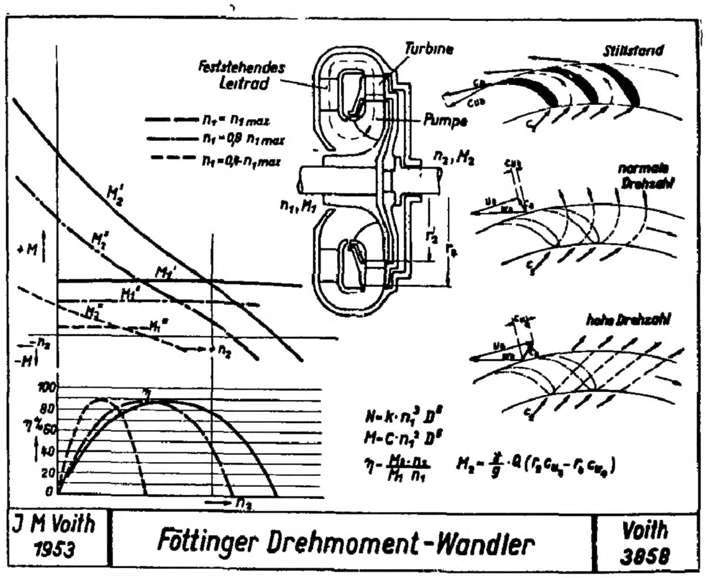


Föttinger converter for ship propulsion.

The so-called "Foettinger transformers" developed at the time were used to transmit powers as high as 50,000 HP. from a fast-running steam turbine to a slow-running ship screw propeller, as at that time it was not yet possible to manufacture gears for the high powers required in this case. Fig. 2076 shows such a "Foettinger transformer" incorporating a large torque converter rated at 16,000 HP. for forward running, the step-down ratio being between 1,000 : 180 rpm. The smaller torque converter, in which the direction of flow is reversed, is used for running astern. These torque converters are switched on and off by filling and emptying manoeuvres.

In the meantime the hydrodynamic power transmission system has been perfected to a very high degree, and today millions of HP. are transmitted all over the world by fluids in the most varied drives used in ships, locomotives, railcars, automobiles and many stationary machines.

The elements of hydrodynamic power transmission are torque converters and hydraulic couplings. In the torque converter the torque supplied by the engine is so converted that with a practically constant input a high torque is made available at the turbine shaft at low speed and a low torque at high speed. The hydraulic coupling, on the other hand, transmits the torque unchanged, but also permits of different speeds of the driving and the driven shafts. This different effect of these 2 equipments is of course caused by differences in their construction.



Föttinger Torque converter.

M_1' ; M_1'' ; M_1''' Input torque at various input speed n_1
M_2' ; M_2'' ; M_3''' Output torque at various input speeds
input speed n_1 : efficiency η
output speed n_2

In order to obtain in the case of the torque converter a difference between pump and turbine torque, in addition to these two members a third member is required—a stationary guide wheel—which takes up the difference between these two torques. In the case of the hydraulic coupling, on the other hand,—as will be shown later—only two members are used: a pump and a turbine.

In order to illustrate the function of the torque converter the flow through the blading of the turbine runner is shown for various conditions: for starting, for normal and for runaway speeds. If it is assumed that the pump impeller is driven at constant speed, the impeller moves the fluid towards the turbine in the direction marked by arrows. As long as the turbine runner stands still, because of the blading being bent backward, the fluid is heavily deflected and therefore considerably slowed down in the peripheral direction, so that a large torque is set up at the turbine runner. This torque is many times larger than that of the pump impeller. Under the action of the torque thus set up the turbine runner starts revolving. As the speed of the turbine runner increases, the deflection and hence the deceleration of the liquid decreases until eventually, as may be gathered from the illustration to the right at the bottom, no deflection occurs at the runaway speed. The curves in the left-hand portion of the illustration show that as the turbine speed n_2 increases, the torque M_2 gradually decreases, dropping to "O" at the runaway speed. This torque curve has the same character as for instance that of a D. C. traction motor, in which the speed is automatically adjusted to the load to be handled.

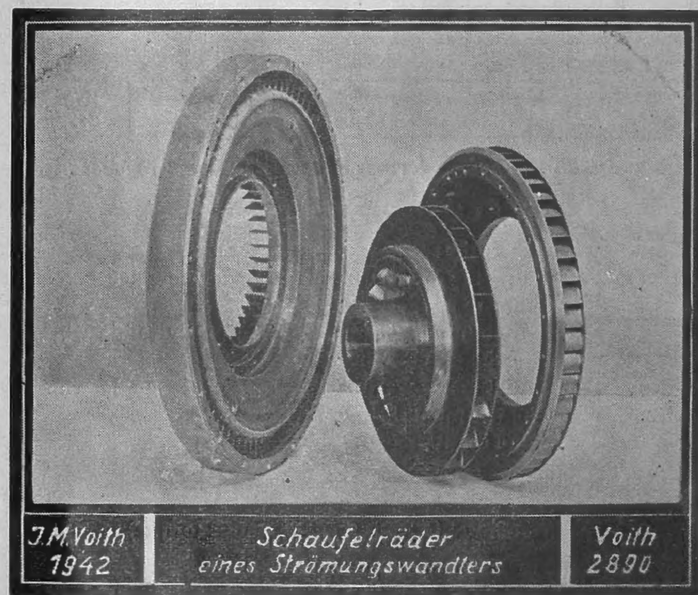
The liquid coming from the turbine runner enters the stationary guide wheel with a velocity which varies considerably. In the case of the Voith converter, shown in the illustration, the liquid is returned to the pump impeller without any change in direction, because the stationary guide wheel is arranged directly before the pump. As a result of this, for the various operating conditions the torque M_1 absorbed by the pump also remains practically constant.

If a change in the pump speed occurs

(a) the power transmitted varies as the third power;
(b) the torque varies as the square;
(c) the speed varies as the pump speed.
(d) The efficiency remains practically constant but is shifted to another turbine speed that varies in direct proportion to the pump speed.

The illustration reproduces the torque curves for three different pump speeds: full speed, 2/3 and 1/3 full speed. It can readily be seen that by varying the pump speed or the speed of the driving engine, the torque converter allows of operation over a very wide range.

As in the case of all hydrodynamic machines the efficiency of the torque converter is dependent on the dimensions, the finish of the blade surfaces and the viscosity of the working fluid. In addition to this, the ratio turbine speed : pump speed, for which the torque converter has been designed and which gives maximum efficiency, plays a major part. Depending on these factors, efficiencies as high as 90% may be reached.



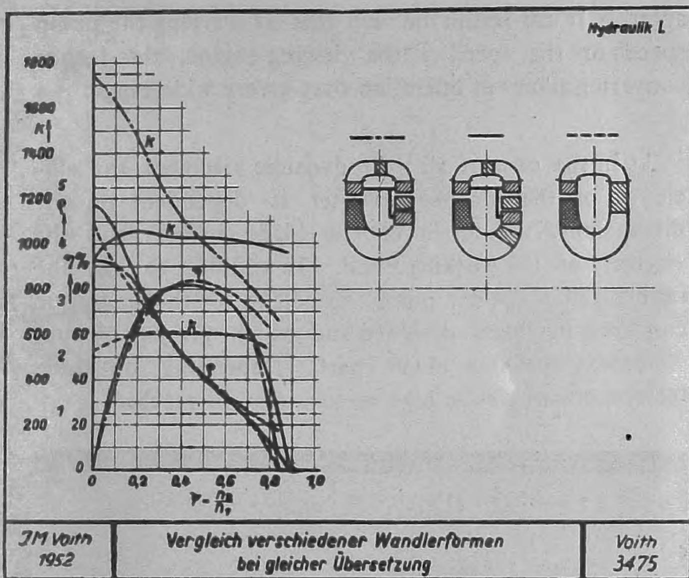
Vaned wheels of a torque converter

From left to the right:

(a) stationary guide wheel
(b) pump impeller
(c) turbine runner

Illustration 2890 shows the members of a Voith torque converter: from left to right—the stationary guide wheel, the pump impeller and the turbine runner.

The various torque converters, which have become known, differ with respect to the number of the rows of blades, the sequence of pump, turbine and guide wheel and with respect to the ratio turbine speed : pump speed for which the efficiency is an optimum (design point). In the technical literature it has often been claimed that in order to obtain a high, flat efficiency curve several turbine stages are required. However, this is only true, if in the direction of flow a turbine stage is provided ahead of the pump as shown in fig. 3475 a. With this arrangement, as the speed of the turbine part varies, also the direction of flow at the outlet of the turbine



Comparison of various formes of torque converters designed for the same speed ratio γ

From left to the right:

(a) 3 stage turbine converter with last turbine stage before the pump impeller.

(b) 3 stage turbine converter with a stationary guide wheel before the pump impeller.

(c) 1 stage turbine converter with a stationary guide wheel before the pump impeller.

K = specific input

η = efficiency

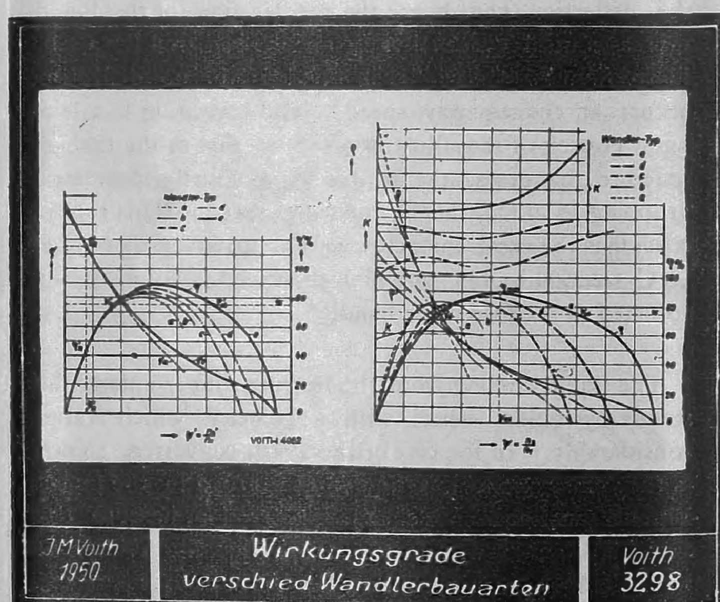
p = torque ratio (output torque : input torque).

part and hence also at the inlet of the pump impeller so that, as a result of this, the input of the pump also varies. From the value K, which represents the input at constant pump speed, indicated for this arrangement, it may be gathered that the input steeply increases as the turbine speed decreases, which means that when a Diesel engine is used as driving machine, the speed of the engine heavily drops in the low rail-speed range. In order to obtain with such an arrangement a satisfactory increase in torque, or in other words, a flat efficiency curve, several stages must be provided in the turbine part.

If, however, as shown in fig. 3475b, a stationary guide wheel is interposed between the last turbine stage and the pump, for the input a K value is obtained that is practically constant.

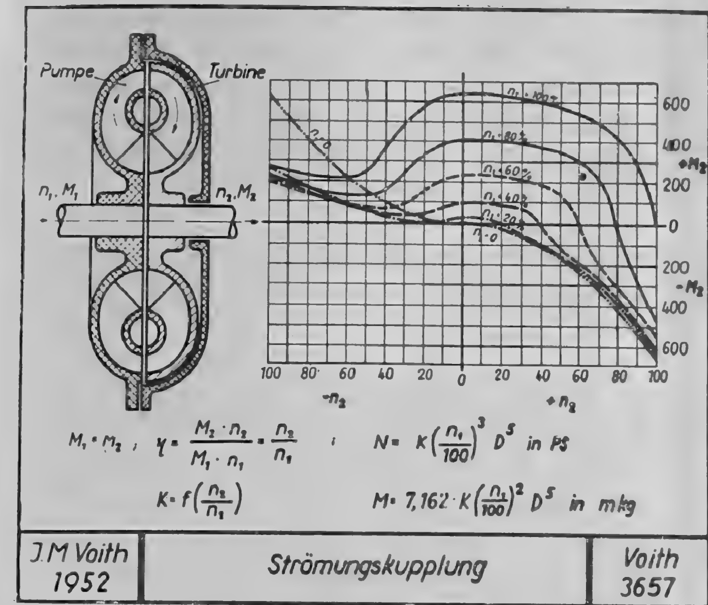
Fig. 3475c shows a torque converter with one single turbine stage. As may be gathered from the curve, in this case, too, the input is practically constant, the only difference being that in comparison with the arrangement according to fig. 3475b the specific input is smaller as a result of the smaller number of turbine stages. This may readily be compensated by slightly increasing the diameter which is effective with the fifth power. The torque conversion and the efficiency are at least the same.

Fig. 3298 shows the influence of the design speed ratio on the efficiency and the torque conversion for the same single-stage arrangement. Fig. 3298b shows the torque conversion and the efficiencies plotted against the ratio of the turbine speed to the pump speed. It can readily be seen that with a smaller design speed ratio the efficiency and the flatness of the efficiency curve increase, but that at the same time the torque conversion decreases at starting. Often the quality of a torque converter is judged from the torque conversion at starting. However, such practice gives rise to erroneous conclusions and is only permissible, if at the same time the speed ratio is duly considered. For this purpose, behind each torque converter an imaginary step-down gear is assumed, which has such a ratio that behind this



Efficiency of various types of torque converter.
(Wandler Type = type of torque converter)

step-down gear for all torque converters the same starting torque is available. In this way, fig. 3298a has been drawn up. Only under the above assumption, the converters can be compared in a fair way. As may be gathered from fig. 3298, e. g. that converter with the lower design speed ratio, which provides the lowest starting torque ratio, has actually the best efficiencies with respect to the absolute values and the flatness of the efficiency curve.



Fluid coupling.

Principle of design
Transmittable torque at various input speeds n_1 and various output speeds n_2
Input torque $M_1 = M_2$ output torque
input speed n_1
output speed n_2
Profile diameter D

The hydraulic coupling comprises 2 effective parts only: pump and turbine as shown at the left of illustration 3657. In view of this, the torque of the pump is at any time identical which that of the turbine. From this fact it may also be deduced that the efficiency of a coupling is given by the ratio *turbine speed/pump speed.* The difference in speed is called "slip", and the efficiency of the coupling in per cent can also be expressed by 100 minus slip. If it is assumed that the pump is driven at 100% speed, and that there is no load on the turbine runner, this runner will also revolve at 100% or, in other words, at synchronous speed. At such time the centrifugal pressure of the pump will be completely compensated by the counterpressure of the turbine of the same value, and, as a result of this, no liquid can circulate and no torque can be transmitted.

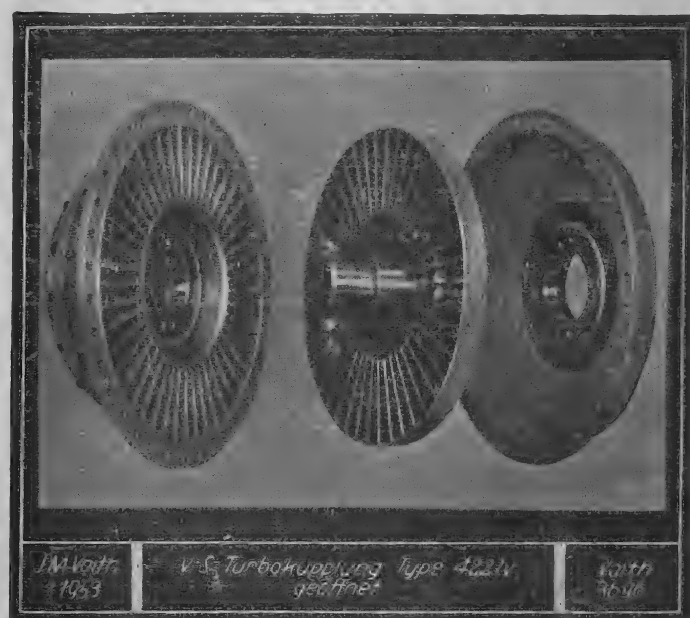
When load is put on the turbine runner, its speed decreases or, in other words, "slip" occurs. At such time a pressure difference is set up, and as a result the liquid is caused to circulate and torque can be transmitted. As may be gathered from the curves, the torque M increases as the speed of the turbine decreases (the slip increases) and when the runner comes to a complete standstill (100% slip), this torque reaches its maximum value.

For the dimensioning of a hydraulic coupling it is considered that the normal torque is transmitted at 2—3% slip or, in other words, with an efficiency of 98—97%.

The illustration also shows the torques for pump speeds below 100%. It can readily be seen that the torque—as in the case of the torque converter—decreases rapidly as the input speed is decreased. For this reason, if it is not possible to overload or stall a Diesel engine, since the transmission of power is discontinued when the engine speed drops.

Contrary to the torque converter, the hydraulic coupling can transmit power in either direction, thus also negative torques ($-M_2$). Power is always transmitted from the part running at the higher speed to that revolving at the lower speed.

Illustration 3696 shows the blading of pump impeller and turbine runner of a hydraulic coupling.



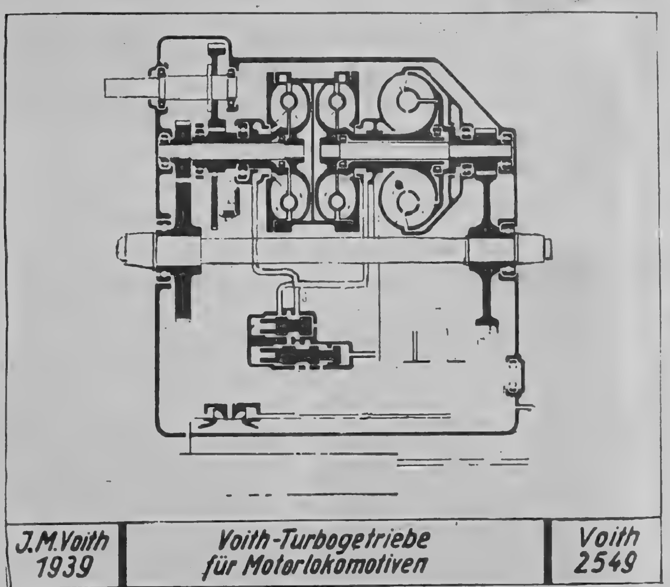
Blading of a fluid coupling.

From left to right:
(a) pump impeller
(b) turbine runner
(c) casing

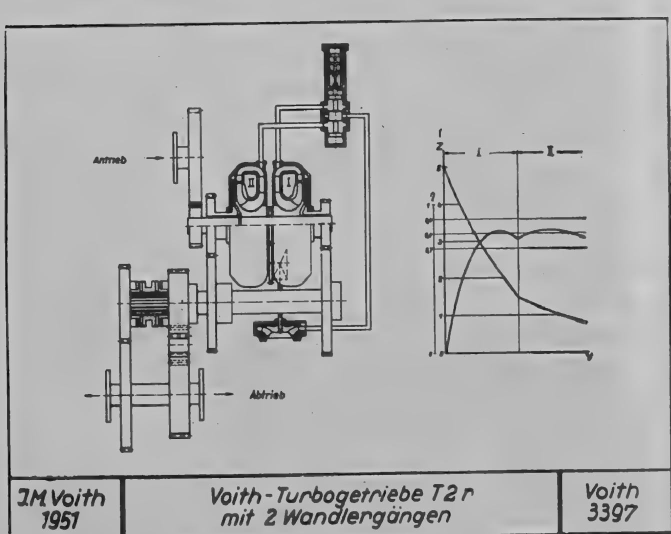
For the operation of rail vehicles such as locomotives and railcars usually high tractive efforts on starting and also a high maximum speed are required. Apart from some special cases such requirements cannot be met by one single torque converter, and, for this reason, the Voith transmission combines the torque converter with

transmission size for the connection with various driving machines. The driving shaft drives a small filling pump, which via a control valve of the piston type furnishes the working circuits with oil. Depending on the position of this valve, the two working circuits are empty or the one or the other circuit is filled and switched on. From the driver's cab, the hydraulic transmission is switched on or off only as a whole as desired; however, the change-over from one working circuit to the next is automatically effected by means of a small governor controlled by the rail speed.

The spring load of this governor—if necessary—can by changed by connection with the fuel lever of the



Voith Turbo Transmission.
with 1 torque converter and 2 coupling speed ranges



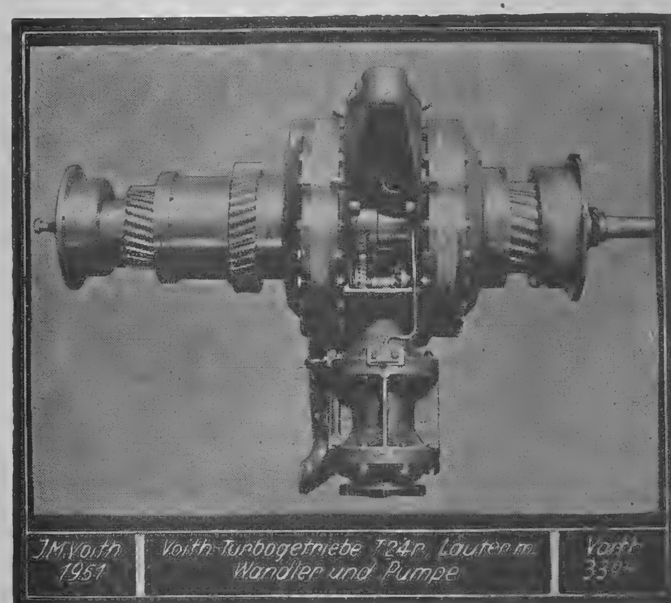
Voith Turbo Transmission.
with 2 torque converters. Diagrammatic arrangement tractive-effort-speed diagram.

driving machine so that as the power of the latter decreases the change-over speed also decreases.

Fig. 2549 shows a similar transmission, which in this case is equipped with 2 couplings.

Fig. 3397 shows a hydraulic transmission incorporating 2 torque converters I and II, which are of identical design; however, between the 2 turbine runners and the output shaft different step-down gears are interposed, so that a sequence of converter stages results. In this case also a reverse gear is fitted.

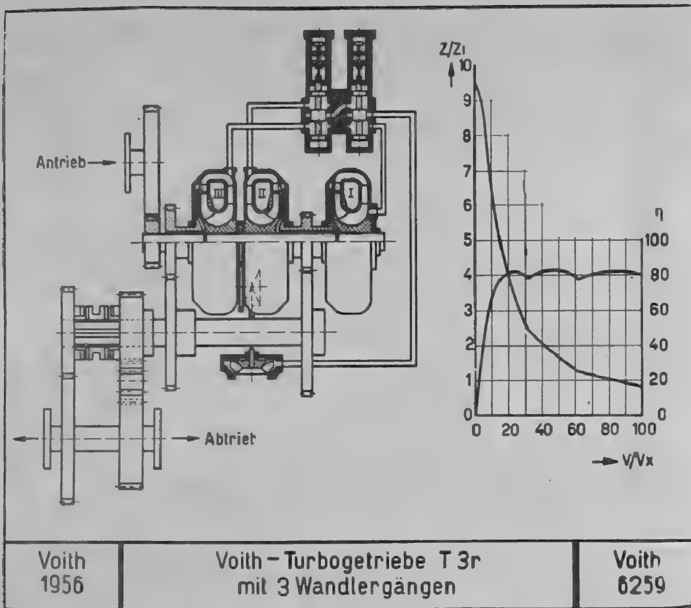
Fig. 3395 shows the runner of the transmission illustrated in fig. 3397. The two torque converters together with the filling pump and the control constitute a compact unit, so that the short distances give short times for the filling and emptying manoeuvres.



Voith Turbo Transmission.
with 3 torque converters. Diagrammatic arrangement tractive-effort-speed diagram.

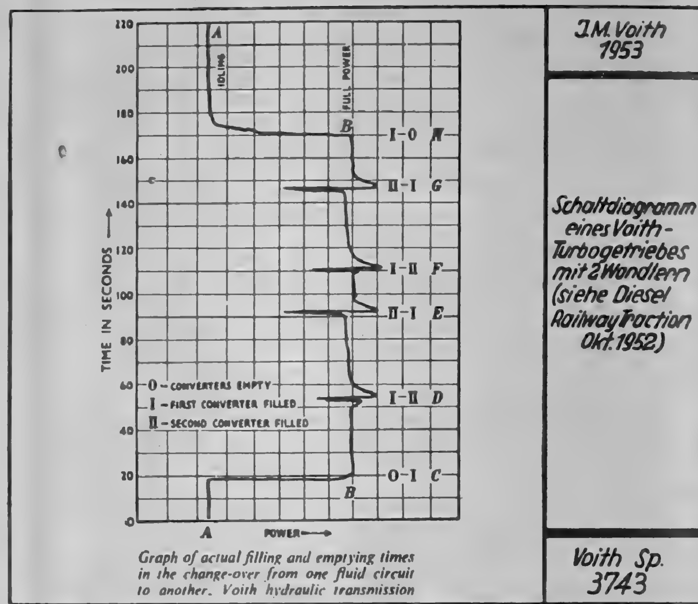
Fig. 6259 shows a transmission incorporating three torque converters and a built-in reverse gear. The addition of a further torque converter for a higher hydraulic transmission ratio than that of the other converters has allowed to further boost the tractive efforts in the starting and low-speed range.

Fig. 3742 shows the revolving parts fitted inside the housing. At the extreme left is the housing of the first torque converter and at the right that of the second and third converters with the output gearing. At the extreme right the step-up gear for the pump portion is visible.



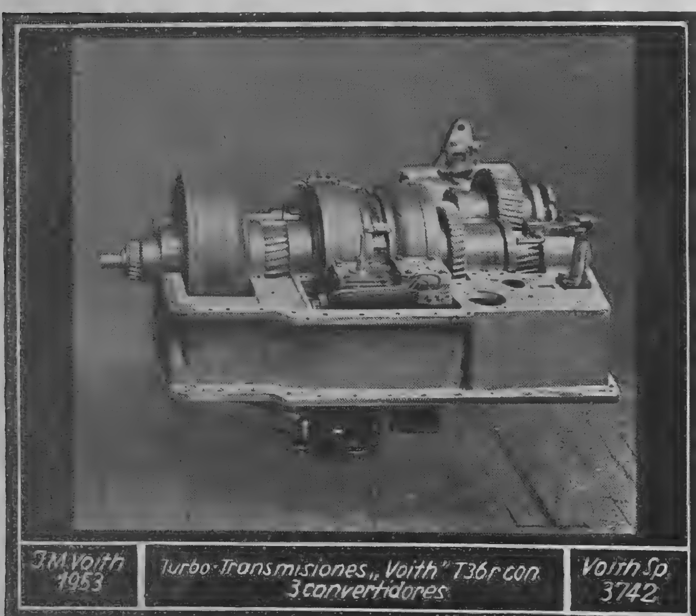
Rotor of a 2 torque converter transmission.

(a) torque converter I
(b) torque converter II
(c) filling pump



Wattmeter diagram showing the power absorbed in function of time in seconds during filling and emptying manœuvres with a 2 torque converter Voith hydraulic transmission.

(C) o — I starting with torque converter I
(D) I — II Changing over from torque converter I to II
(E) II — I Changing over from torque converter II to torque converter I etc.



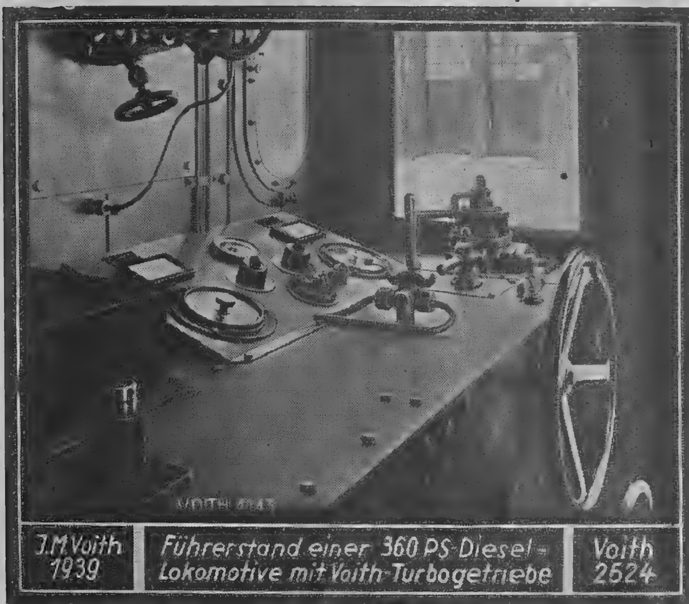
Voith Turbo Transmission with 3 torque converters open.

(a) torque converter I
(b) torque converter II
(c) torque converter III

The method based on the automatic switching on and off of hydraulic circuits by filling and emptying manoeuvres such as applied by Voith to their hydraulic transmissions has as no other design proved to meet all practical requirements. By improving the æration of the working circuits by selecting a filling pump of proper size and a suitable control, extremely rapid starting and a change-over without any noticeable power flow discontinuity can be accomplished. This has been achieved by an overlapping of the emptying of one working circuit by the filling of the next. Fig. 3743 is a graph showing the power consumption during the actual filling and emptying in the change-over from one fluid circuit to another. The values have been determined on the test bench with a transmission comprising two torque converters. It will be seen that after starting within one second the full power is absorbed as evidenced by the graph at point B when changing over from " idling " to converter I. When changing over from converter I to II at point D and back again from converter II to I, at point E etc. only a small variation in power and hence in the tractive efforts occurs.

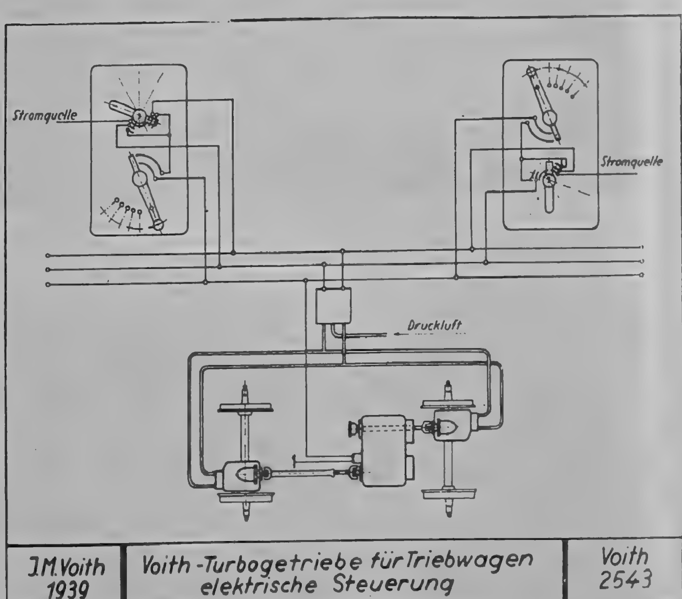
In contrast with this transmission any other transmission in which, e. g. a permanently filled torque converter is followed by a change-speed gear engaged by clutches a complete interruption of the power flow cannot be avoided.

As all change-over manoeuvres in the Voith transmission are fully automatic, the control to be effected by the engine driver is extremely simple. As may be gathered from fig. 2524 showing the driver's cab of a Diesel-hydraulic locomotive fitted with a Voith transmission, the



Control arrangement in the cab of a Diesel Hydraulic Locomotive.

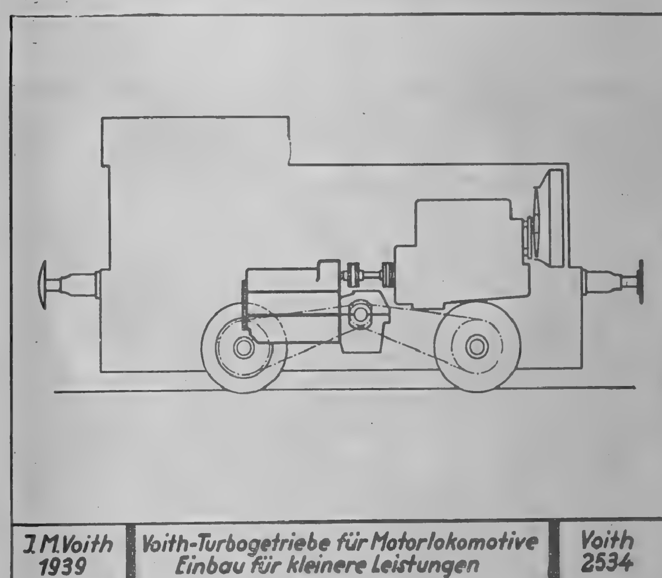
control calls for the operation of a handwheel only. With the handwheel in position "O", the engine is "idling"; at such time the hydraulic transmission is completely empty and switched off. When the handwheel is rotated further away from the "O" position, the engine continues to idle, but the transmission is being filled. In the following positions of the handwheel the engine is gradually adjusted to its full loading, while the transmission stays filled. When the handwheel is brought back to the "O" position, coasting is possible with the transmission empty. As soon as the transmission is switched on again, while the vehicle is in motion, that working circuit is automatically filled which handles the prevailing momentary rail speed range.



Multiple and remote electric control for Voith Transmission and 2 axle reversing gears for a railcar.

This illustration (2543) shows the electrical remote control of several hydraulic transmissions, such as used for railcars. The control of the power transmission only requires one impulse for the starting and stopping of the transmission as a whole, one impulse for forward running and one impulse for reversing, thus a total of three impulses only. This extremely simple control also permits without any difficulty whatsoever the common operation of several Diesel-hydraulic vehicles from one cab.

When small power and low speeds are involved, the simple chain drive may be used. This simple drive has been fitted as standard equipment in more than 600 small shunting locomotives of the German Federal Railways equipped with hydraulic Voith transmission.

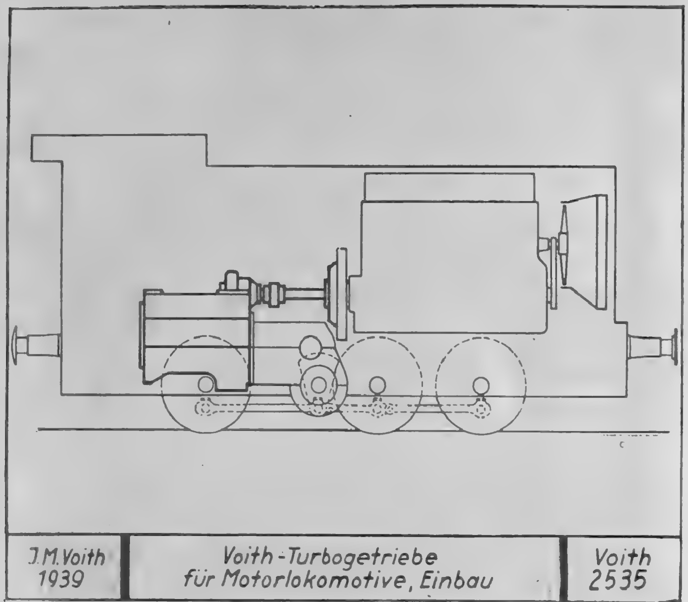


Diesel Hydraulic installation diagram for chain drive.

Fig. 2535 shows a rod drive which is very popular. In this case, the jackshaft drive is as a rule fitted with two speed ranges: a high-speed for line service and a lower speed range for shunting. Switching over from one speed range to the other is effected with the locomotive at rest. Several hundred locomotives of this type were used during the war for military purposes and have been found extremely satisfactory also when operated by unskilled personnel. So far locomotives fitted with rod drives have been built in units of 50—1,400 HP. each.

Fig. 2807 shows a 550-HP. locomotives of this type.

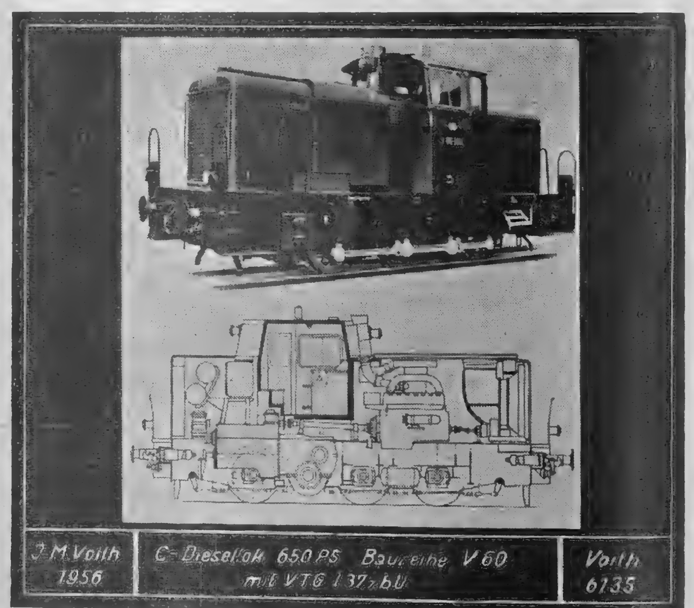
Fig. 2146 shows a 1,400-HP. locomotive with hydraulic Voith transmission, which is the biggest unit of a transmission designed and built so far.



Diesel Hydraulic installation diagram for side rod drive.

1400 HP. Diesel hydraulic 1-C-1 locomotive with Voith Transmission (built in 1935)

Diesel hydraulic D-locomotive with Voith Transmission.

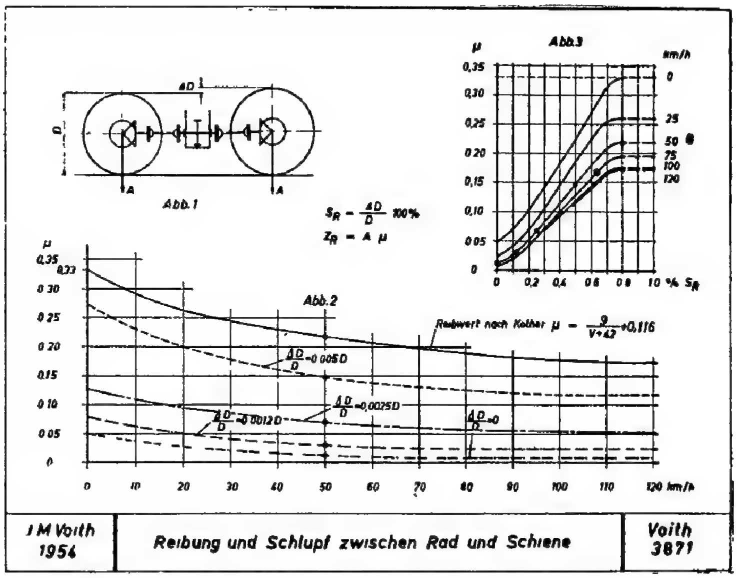


Diesel hydraulic C-Locomotive V 60 of the German Federal Railway with Voith Transmission.

A more recent 650-HP. Diesel locomotive is shown in fig. 6135. In this type V 60 of the German Federal Railways, all experience has been used that has been available to this day. Of this type 300 locomotive fitted with Voith turbo-transmissions are being manufactured for the German Federal Railways.

It has frequently been maintained that the hydraulic power transmission is suitable for a few hundred HP. and for steel-frame locomotive and for rod-driven steel-frame locomotives only. Apart from the fact that already for more than twenty years bogie drives have been used in railcars of 650 HP. per bogie, for some years already such drives by hydraulic power transmissions have been fitted in locomotives for 1,000 HP. and more per bogie, and with this arrangement also extremely good results have been obtained.

As soon as the bogies became an element of the drive incorporating hydraulic transmissions, the question was raised, whether the axles should be driven individually or could be coupled rigidly, i. e. whether each pair of



Rolling friction and slip between wheel and rail.

At the top left: Diagram showing 2 pairs of driving wheels coupled together of different diameters D and D + $\triangle$D.

below: Variation of the value of co-efficient μ for different values of $\frac{D}{D}$ and of the running speed V.

At the top right: Variation of μ as a function of the rolling slip S_R for different constant running speeds.

A = axle load

$S_R = \frac{\triangle D}{D}$ 100 in %; rolling slip resp. percentage of difference in wheel diameter.

$\mu = \frac{Z_R}{A}$ friction coefficient, resp. specific parasitic effort at the wheel periphery.

Z_R = parasitic effort at the wheel periphery.

wheels should be driven by a special hydraulic drive including reverse gear or if all the axles or groups of axles coupled together should be driven by one set of hydraulic drive. This latter drive is not only cheaper to build but its operation and the control of the transmission is simpler and clearer. It also has the advantage of reducing the slipping of the wheels.

In a large number of bogie drives fitted with hydraulic Voith transmissions an independent drive of the 2 axles had been adapted. For this purpose twin transmissions were used, each half driving one axle. Though it is generally known that in the case of steam locomotives several axles which are rigidly coupled can operate without giving any trouble, at the time an independent drive for each axle had been regarded as imperative. However, the actual phenomena in connection with the interaction between wheel and rail were not fully understood. The general opinion was that an effective slip between wheel and rail would occur whenever there is a difference—however small—in the diameters of the driving wheels. Furthermore it was feared that such a slip could only occur by overcoming the usual high friction coefficient, as shown in illustration 3871, by the curve in full lines (Kother's friction coefficient) plotted against the rail speed.

In the meantime laboratory tests and practical tests in the field have given a better insight into this problem. It has been found that the usual friction coefficients occur only, if the difference in the diameters of the driving wheels is at least 0.7%, whereas smaller differences in the diameters are more or less absorbed by the elastic deformation of the material concerned of which rail and wheel consist at the point of contact and that accordingly a much lower "pseudo friction coefficient" must be taken into account.

In the illustration the "pseudo friction coefficients", which have been determined by torque measurements on the cardan shafts of a bogie, have been plotted against the rail speed for various diameter differences $\triangle$ D : D = 0; 1.2; 2.5—5‰. In the upper corner at the right the graphs show the effect of the differences in the diameters at constant speed. It will be noted that in case of differences in the diameters of 1—2‰, only a fraction of the anticipated friction coefficients have to be taken into account. In this context it should be mentioned that also with a diameter difference = 0, friction coefficients which should better be called "parasitic power factors" occur of the same magnitude.

Statistics compiled in railroad repair shops have revealed that with steam locomotives which had run 100,000—150,000 km. the difference in the wheel diameters were on the average as small as abt. 1‰ to 2‰, which means that the wheels actually show even wear and tear, so that no major "parasitic power" can occur. In view of the above, no objection can be raised against a group drive of the axles, and it is therefore feasible to arrange for a simple drive in the bogie through cardan shaft and axle drive, and this the more since there is no difficulty whatsoever to handle by one transmission, e. g., according to the Voith design, the higher power required to drive a group of several axles.

In this way the basis was available for a correct calculation of the forces and the HP which have to be transmitted by the cardan shafts and axle drives. However, in order to eliminate such stresses in addition to the effective torques required for traction as can be set up in the cardan shafts, as a result of differences in the angular velocity and hence by additional forces due to

the rotating masses involved, the laws governing a kinematically correct arrangement should be followed to largest extent possible. A uniform angular velocity at the input and output shafts interconnected through a cardan shaft is obtained under the following conditions:

The driving and the driven shafts must be situated in one common plane, and the angles which the shafts form with the connecting cardan shaft must always be the same. This can be accomplished, if either the one or the other of the following two conditions with respect to the relative location of the driving and the driven shafts are met.

First case: The driving and the driven shafts are and remain parallel to each other, even if there is any shifting.

Second case: The driving and the driven shafts form an angle. If with a change of the angle between the driving and the driven shafts, the angles formed with the connecting cardan shafts are to remain constant, it is imperative that the distances of the pivots from the joints of the cardan shaft remain the same.

It should be stressed once more that in the plan view the basis may not be another arrangement of the shafts than in the elevation. Hence the prerequisite that a plane must pass through the shafts to be connected.

As an example, with the help of fig. 6136 the driving connection between a shaft is the bogie and a shaft rigidly supported in the frame and their behaviour on negotiating a curve will be discussed. In order to obtain good kinematic conditions, the arrangement is such that the distance of the pivot from the cardan shaft joint located in the bogie is the same as the distance of the pivot from the joint located in the frame (case 2).

The maximum angle α between frame and bogie is found from the smallest curve radius R and the pivot distance L.

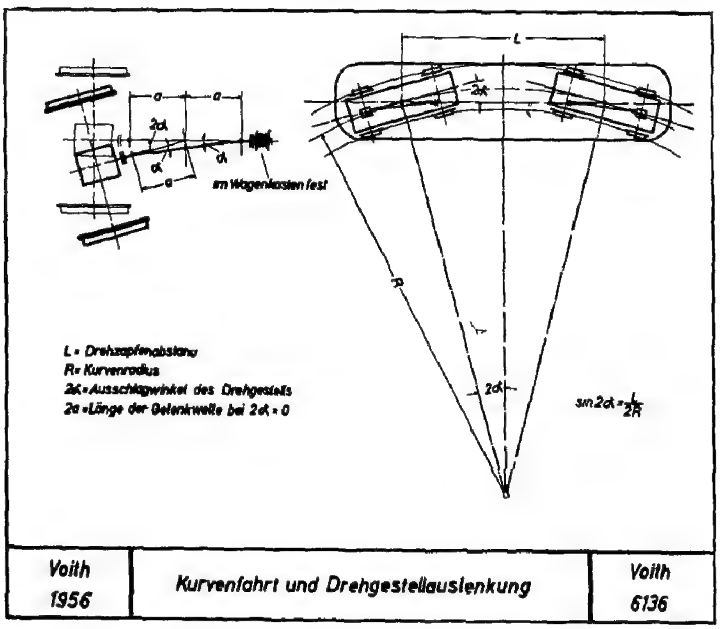
$$\text{Sin } 2\alpha = \frac{L}{2R}$$

For a practical example, where the pivot distance L=9.00 m and the curve radius R=100 m.,

$$\text{Sin } 2\alpha = 9 : 200,$$

or, in other words, the maximum angle at the cardan shaft

$$\alpha = 1^\circ 17'$$



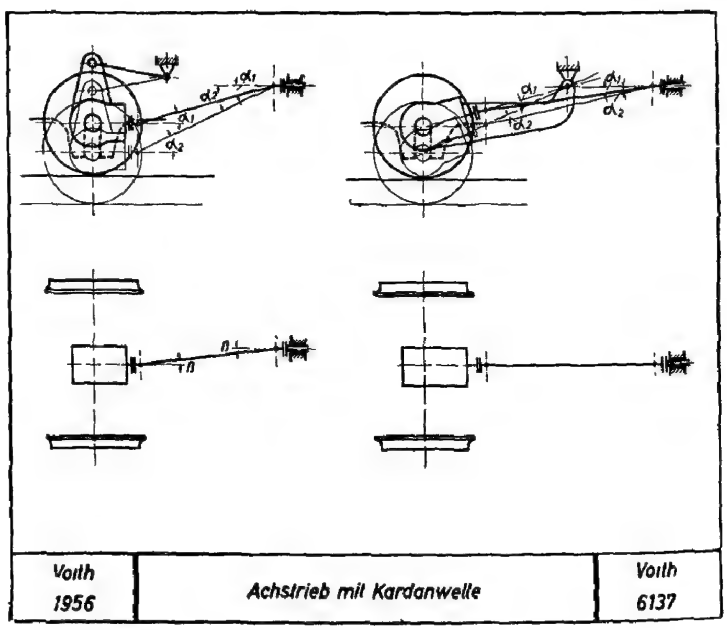
Angle between truck and frame when driving through a curve.

L = Distance between bogie pivots

R = Curve radius

2 = angle between truck and frame

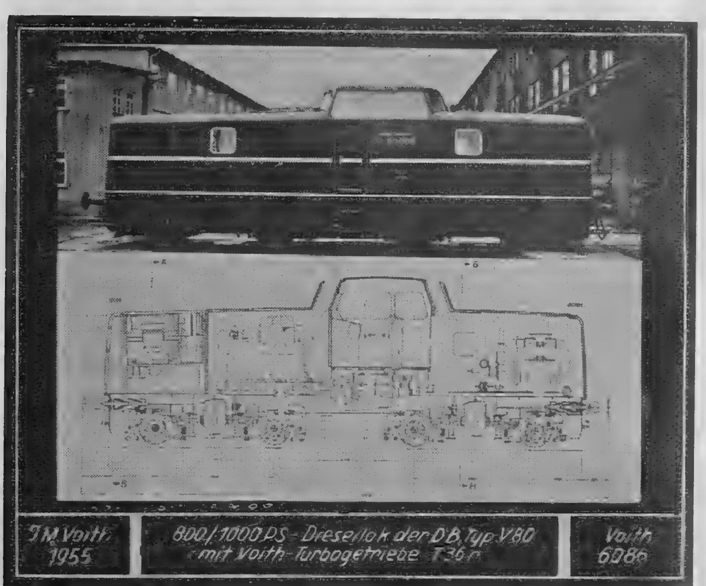
2a = length of cardan shaft between joints



Cardan shaft arrangement for axle drives.

In fig. 6137 further examples are shown: axle drive driven by a cardan shaft with alternating resilience, at the left for case 1 and at the right for case 2. In this context, the different methods of supporting the axle drives should be noted.

In most cases it is not possible to meet this prerequisite with absolute mathematic accuracy. However, the irregularities which occur are with respect to their effect mitigated due to the resilience inherent in any driving system. It may in many cases be advisable to arrange for an additional resilience by using a flexible coupling or a flexible suspension of the torque reaction levers.



1000 HP. Bo-Bo-Diesel hydraulic locomotive type V80 of the German Federal Railway.

Prompted by the extensive experience in the past, the German Federal Railways have decided to develop as first stage machinery of 800/1000 HP. which can be used both in bogie-Diesel locomotives of 1000 HP. and in 2000-HP. locomotives in the form of two such installations, and which are also suitable for use in railcars. The first of these locomotives is Lok V 80 shown in fig. 6086, of which for the first stage of the program 10 locomotives have been built for the German Federal Railways, so that extensive experience can be gained before further vehicles will be built on a larger scale.

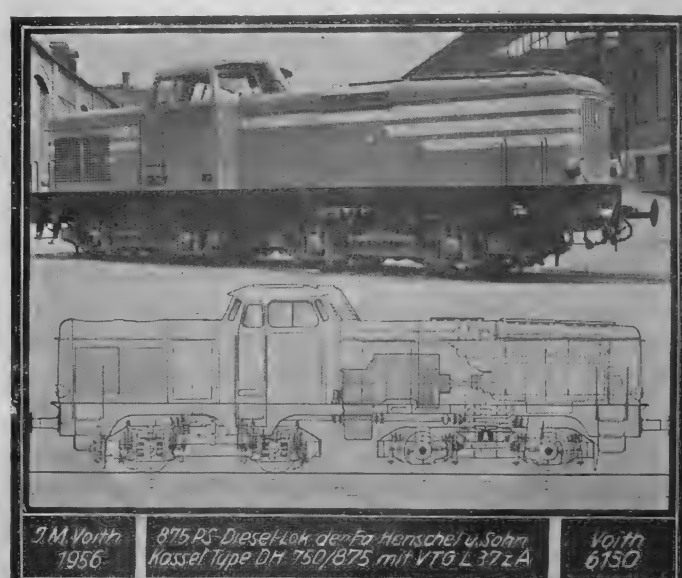
This design is characterized by the fact that all axles of the two bogies are rigidly connected through bevel gear axle drives and cardan shafts and that further these axles are driven from one single power transmission located in the frame in the center of the locomotive. Though when negotiating a curve the above mentioned conditions for cardan shafts are not fully met, excellent results have been achieved due to the use of the inherent resilience.

Fig. 3848 shows another BB-Diesel hydraulic locomotive with two bogies in which also all 4 axles are rigidly connected through cardan shafts. For this application the axles are driven through worm wheels.

In this context, also the BB-locomotive according to fig. 6130 should be mentioned which has been built by Messrs. Henschel & Sohn of Kassel. In this locomotive the four axles are coupled through cardan shafts and bevel gear axle drives.

Subsequent to the development of the V 80, the German Federal Railways have developed a 2000-HP.

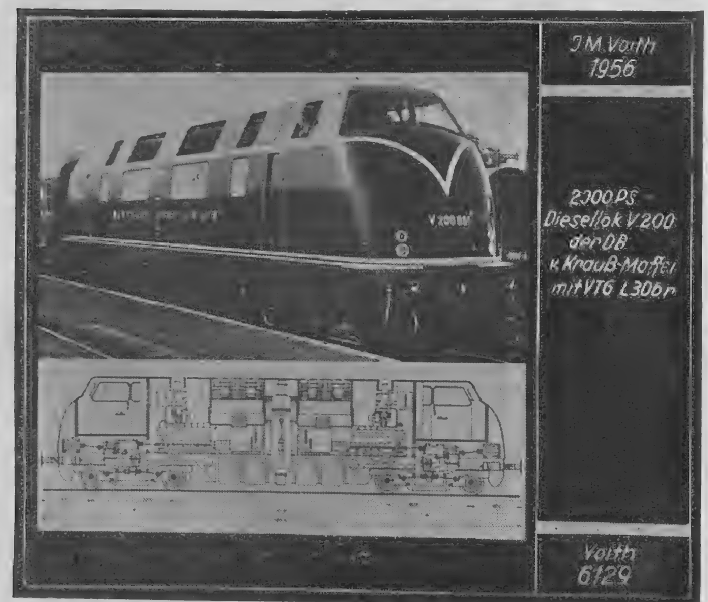
720 HP. Bo-Bo-Diesel locomotive with 3 torque converter Voith hydraulic transmissions for French colonial railway (CFCO).



875 HP. Bo-Bo-Diesel locomotive (Henschel & Sohn, Kassel) with Voith hydraulic Transmission.

locomotive of which in fig. 6129 an external view and a longitudinal section are shown. In this case, for each of the two bogies an engine and drive installation has been fitted. Therefore the two bogies are independent from each other, and only the two axles of the same bogie are interconnected rigidly.

Of this type for the first stage only a few trial locomotives had been built. After these locomotives had been found satisfactory during several years, the building program has been extended so that in the near future a total of 60 such 2000-HP. Diesel-hydraulic locomotives will be operated by the German Federal Railways.



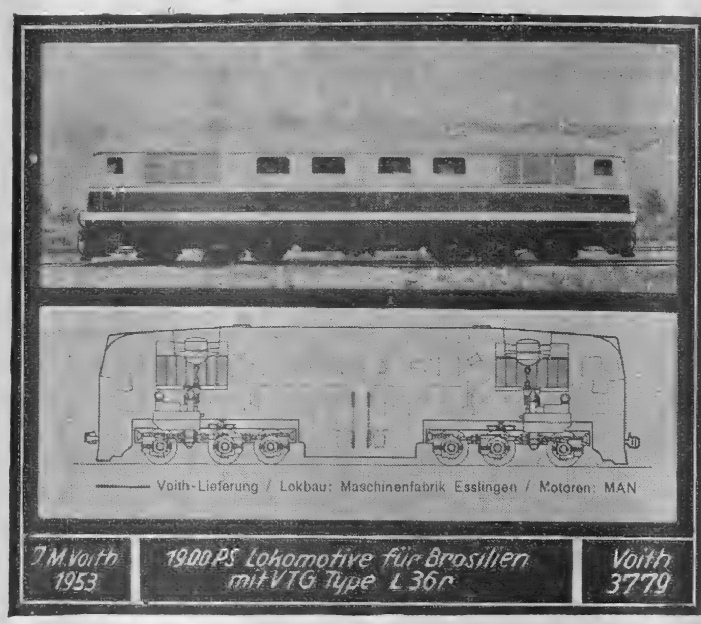
2000 HP. Bo-Bo Diesel locomotive (Krauss-Maffei, Munich) with 3 torque converter Voith hydraulic transmissions for the German Federal Railways (Diesel engine speed 1500 r.p.m.)

At the same time the 1900-HP. locomotive shown in fig. 3779 has been developed. This locomotive is of particular interest since it was built for 1000 mm. narrow-gauge and an axial pressure of 13 tons only. It was fitted with 2 three-axle bogies, all being driving axles (manufacturer Maschinenfabrik Esslingen). In this case, too, for each of the bogies a separate machine installation has been used.

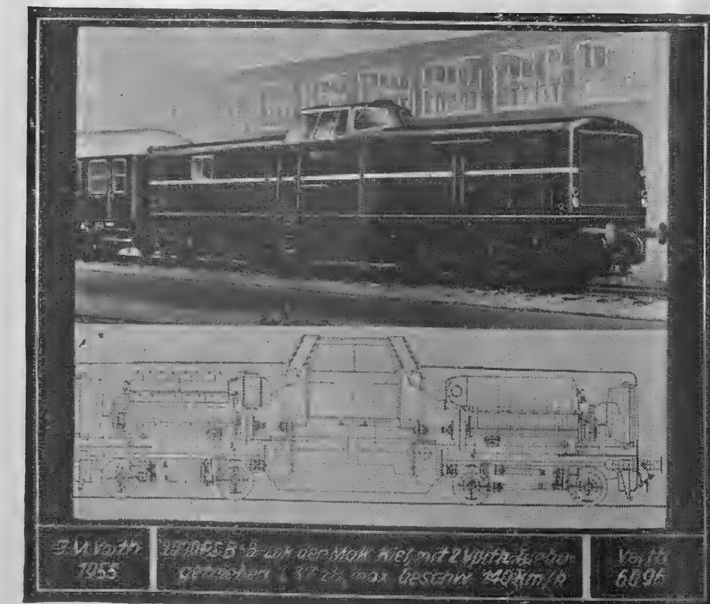
Another 2000-HP. Diesel-hydraulic locomotive built by Messrs. MAK of Kiel is shown on fig. 6096.

As the last locomotive of this type, the 2000-HP. locomotive built by Messrs. Klöckner-Humboldt-Deutz should be mentioned. It is shown in fig. 6131.

With respect to the use of the hydraulic power transmissions as drive of railcars, there will be little



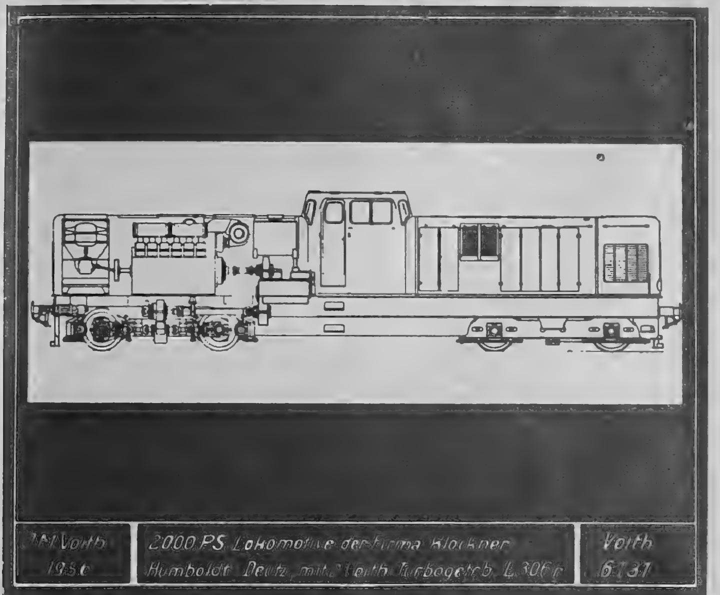
1900 HP. C'C' Diesel locomotive (Maschinenfabrik Esslingen) with 3 torque converter Voith hydraulic transmissions (Diesel engine speed n=900 r.p.m.



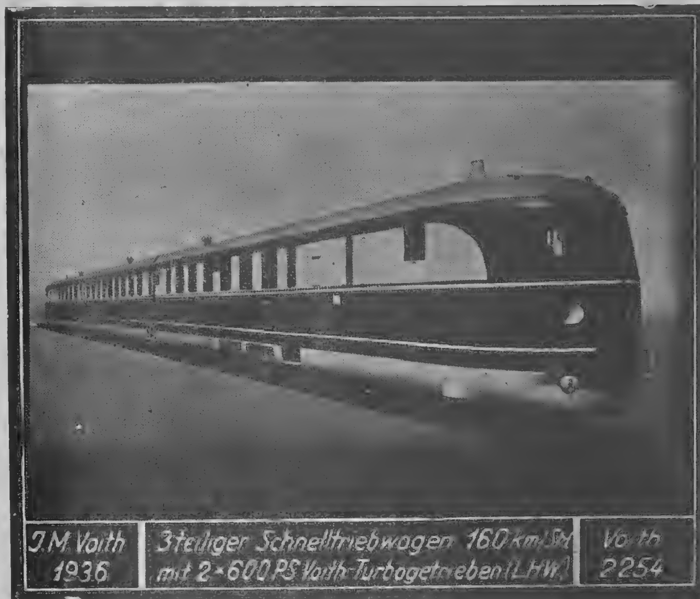
2000 Bo-Bo Diesel locomotive (MAK in Kiel) with Voith hydraulic transmissions (Diesel engine speed n=750 r.p.m.)

disagreement among the experts as to the advantages presented by this power transmission. For this application ample practical experience extending over many years is already available.

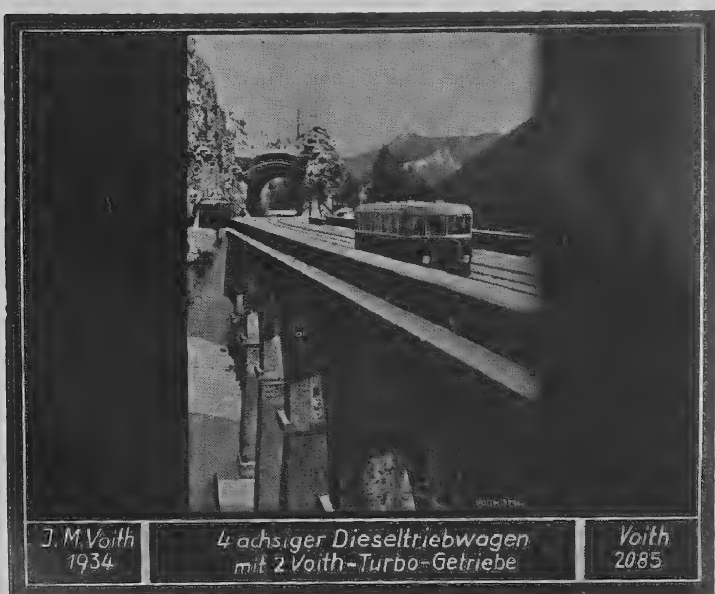
The rail vehicle which was the first to be equipped with a Voith transmission in 1933 was a rail bus for the Austrian Federal Railways according to fig. 2085.



2000 Bo-Bo Diesel locomotive (Klöckner-Humboldt-Deutz in Cologne) with Voith hydraulic transmissions (2 stroke Diesel, n=750 r.p.m.)



1200 HP. triple articulated express Diesel train (2 Diesel engines, 2 Voith Transmissions) for the German Federal Railways (built in 1935)



4 axle railbus with 2 Voith transmissions (built in 1934)

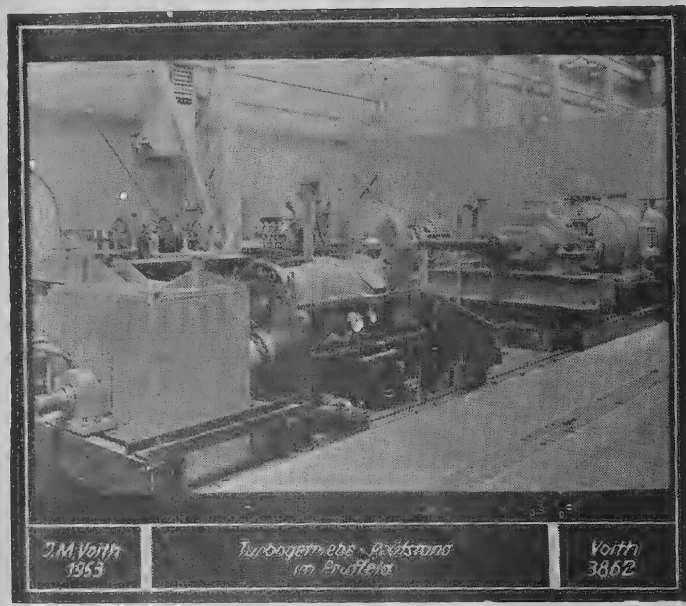
1000 HP. articulated express Diesel train with 3 torque converter Voith Transmissions for the German Federal Railways.

Illustration 2254 shows triple-articulated express rail-cars of the German Bundesbahn which were the first to be equipped in 1934 with 2 engines of 600 HP. each. The complete machine equipment: engine, hydraulic transmission and axle drives have all been accommodated on the bogie.

As already mentioned above, the 800/1000 HP. machinery developed primarily for the V 80 locomotive has also been fitted in the express railcars of the German Federal Railways. Such an express railcar is shown in fig. 6063. In this case, too, the entire machine equipment is fitted in the bogie and the 2 axles of the bogie are rigidly coupled as is the case with the railcar according to fig. 2254.

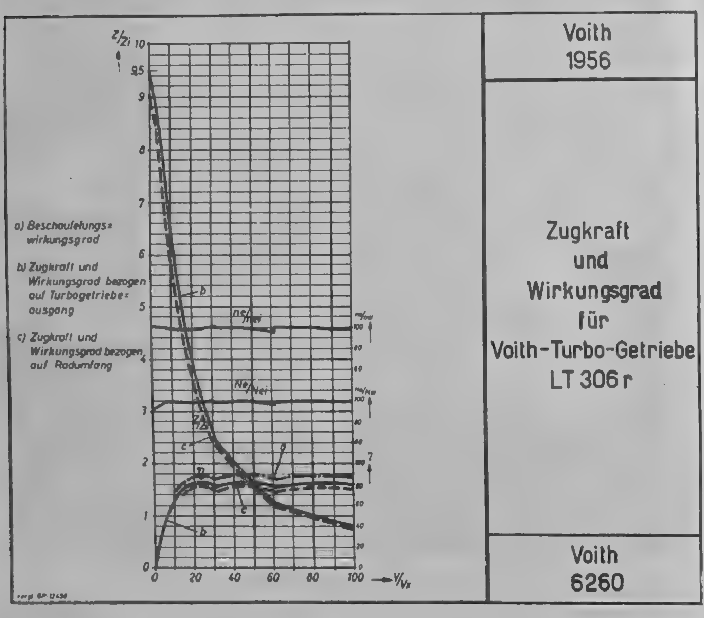
Another example of a hydraulic drive is shown in fig. 4385. This example shows one of the triple-articulated

1100 HP. triple articulated Diesel train for the Turkish State Railway (2 engines, 2 Voith Transmissions)



Voith Transmission on the test bed.

Diesel trains for the Turkish State Railways. The interior of the driving car, the Diesel engine, the hydraulic transmission, the axle drives and the cooling equipment are shown in fig. 3887.



Efficiency and specific tractive efforts for a 3 torque converter Voith hydraulic transmission.

(a) efficiency and specific tractive efforts based on the losses in the torque converters
(b) efficiency and specific tractive efforts applying from input flange to output flange of the transmission
(c) efficiency and specific tractive efforts as under b but deducted by the losses in the cardan shafts and axle drives i.e. applying from input flange to axle.

The efficiency η and the relative tractive efforts Z/Z_i for a turbo-transmission of a 3-stage converter (see fig. 3742) plotted against the relative rail speed V/V_x are shown in fig.—6260—. These apply from input flange up to output flange and include all losses due to the filling pumps, ventilation, toothed wheels, etc.

Illustration 3862 shows the test bench, on which prior to being despatched the transmissions are subjected to a trial run, and efficiency and output measurements are carried out. As drive an electric motor and an intermediate gear are used by means of which the input speed of the transmission is adapted to the Diesel engine speed which will be used. On the output shaft a Prony brake is fitted by means of which the torque at the output shaft is determined.

In a variant of this design instead of a converter a fluid coupling is used as third stage. In this case, not only in the maximum speed range and at full load a substantially higher efficiency (91%) is obtained, but also at part loads and at high rail speed.

In a comparison with the electric power transmission a point in favour of the hydraulic power transmission is the fact that the temperatures in the hydraulic transmission are always under perfect control. For heat considerations with either power transmission system there is a lowest locomotive speed allowing continuous operation with full power. In the case of the electric power transmission the heat losses must be dissipated from the insulated coils of the generators and traction motors. To this effect a blower blows air against the surfaces of the coils, and it can readily be seen that such cooling method has, of necessity, its limitations and cannot be increased beyond a certain point. The cooling surface

can only be enlarged by additional weight. An improvement by an increased cooling air supply is feasible only within certain narrow limits, and furthermore in this case an additional power loss cannot be avoided. But in spite of all these efforts the risk of overheating cannot be eliminated. When with low rail speed a large electric current flows in the coils, the power can be maintained only for a very short time, or in other words, in comparison with the maximum speed, the continuous running speed, at which the full power can be utilized, is relatively high.

The hydraulic power transmission, on the other hand, uses a working liquid, as a rule oil, for the transmission of the power. This liquid ideally lends itself to dissipate the heat losses. To get rid of this heat part of the transmission oil is passed through a cooler and after being cooled returned to the oil reservoir in the transmission gear casing. As cooler a heat exchanger is employed, through which the cooling water of the engine is circulated. This water is only heated up a few degrees and is subsequently cooled in an air-cooled radiator. The control of the oil temperature is exclusively a question of the dimensioning of the oil cooler. Therefore no physical limits are set as in the case of the electric power transmission.

Relatively to the direct cooling of the transmission oil by an air cooled radiator, this system has the advantage that owing to the much smaller difference of temperature between the oil and the engine cooling water the fluctuations of temperature are relatively small even when the amount of heat produced varies widely. Furthermore, as the engine cooling water is automatically kept to as nearly a constant temperature as possible, excessive cooling of the transmission oil is avoided. The lowest operating speed, that is to say the speed at which the full power of the engine can be transmitted during a long period without any anxiety as to excessive heating of the transmission oil, is therefore definitely lower than that allowable with electric traction with which such definite cooling conditions cannot be realized. This feature has great importance when starting and hauling heavy loads up long steep grades.

For the starting of heavy trains, when heavy "tearing-off" resistances may occur, it is essential that not only the heat is effectively dissipated by a suitable cooling equipment, but it is also essential that sufficient masses of metal and fluid are available in order to store temporarily the heat shock, or in other words the "time constant" must be favourable.

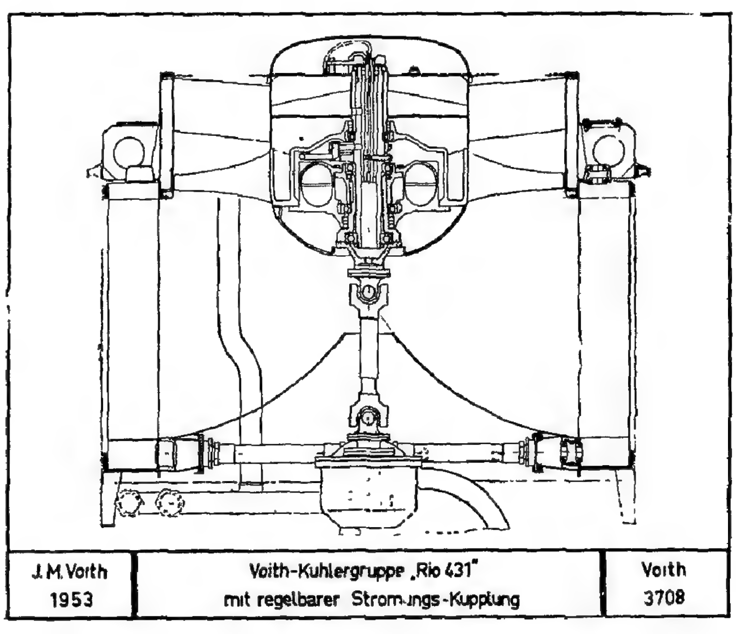
With the hydraulic power transmission, in particular with power transmissions based on the Voith principle, where the working fluid provides the required circulation, an even distribution of the heat is ensured. As already described above, the working fluid communicates with the engine cooling water circuit via a heat exchanger. In this way, for the heat storage not only the mass of the metal and the fluid filling of the power transmission are available, but also the cooling water as well as all metal parts of the engine coming in contact with the cooling water.

With the electric power transmission for the heat storage primarily the copper coils and conductors are used. However, since these parts must be insulated the iron parts in which the coils and conductors are embedded can be used for the heat storage only to a very limited extent.

In this context due consideration must be given to the fact that as compared with metals the specific heat (cal./kg. centigrade) of fluids is 5 to 10 times higher. For the metals the following values are applicable:

Water	1.0	Iron	0.1
Oil	0.55	Copper	0.093.

Also with respect to the capacity of heat storage the hydraulic power transmission is therefore superior.



Cooling Unit with automatic speed regulation fluid coupling within the hub of the ventilator.

Illustration 3708 shows as an example a section of the cooling equipment. A small hydraulic coupling is fitted in the blower hub in order to arrange for automatic adjustment of the cooling to the individual requirements and in order to maintain a practically constant cooling

water temperature. The filling of the coupling is controlled by a small thermostat, thus adjusting the speed of the blower.

The cooling units are self-contained and can readily be removed as a whole.

The promotors of the Diesel-electric transmission claim that the hydraulic transmission can be used to handle inputs up to abt. 300—400 HP. and that for higher inputs the hydraulic transmission is unsuitable. This claim is refuted by the large deliveries by Voith of hydraulic transmissions totalling about 5400 transmissions (supplied until 31.12.1956) with an aggregate power of 1854 000 HP. These transmissions have been designed, manufactured and delivered for the following outputs of locomotives:

less than	100 HP.	313	locomotives
	100— 199 HP.	1774	"
	200— 399 HP.	1415	"
	400— 599 HP.	384	"
	600— 999 HP.	757	"
	1000—1500 HP.	35	"
about	1500 HP.	65	"

From this survey it may be noted that there is a fair number of locomotives in the output range of 1,500—2,000 HP., of which the preceding pictures have illustrated various designs. In this context special mention must be made of the lower weight and the smaller space requirements of the hydraulic power transmission, a point of considerable importance when small-gauge locomotives with low admissible axle pressures are involved.

The promotors of the Diesel-electric power transmission admit that whenever a given job can be handled by one torque converter range, as for instance in the case of shunting locomotives, the hydraulic system is not inferior to the electric system, but they claim that whenever several stages are required to handle a larger speed range, this presents a problem which is non-existent in the case of the Diesel-electric power transmission. However, in this respect it must be stressed that the method used by Voith for the switching-on and off of several working circuits by means of filling and emptying manoeuvres even with highest outputs presents no problem whatsoever contrary to any other method using purely mechanical means for such change-over manoeuvres while the vehicle is in motion. In addition to that any interruption of the tractive efforts during the changing-over is with this method avoided.

CENTRAL RAILWAY BOOKSTALL SUPERVISORY COMMITTEE MEETS

The inaugural Meeting of the Central Railway's Bookstall Supervisory Committee was held at Bombay V.T. recently under the Chairmanship of Shri D. P. Mathur, Senior Deputy General Manager of the Central Railway. Among those present were Sir Vithal Chandavarkar and Shri Joachim Alva, M.P.

The Committee discussed the type and quality of books and magazines for sale at Railway Bookstalls. In accordance with administrative instructions, the sale of books on sex has been prohibited. In the interest of character building of the Nation the sale of Gandhian and Sarvodaya literature is being propagated Tourist literature and literature connected with the developmental activities of the Government in the context of the Second Five-Year Plan are also required to be stocked in adequate quantities.

The Committee recommended the production of small editions of Plan publications dealing with different aspects of the Plan to be sold at popular prices. Their recommendation has been put before the Publications Division of the Ministry of Information & Broadcasting. The Committee have recommended that books on the lives and teachings of Indian Saints be put on sale. This has been accepted and necessary action has been taken to provide such literature in the Railway Bookstalls.

Suggestion Books are being provided at Book-stalls at stations in which the travelling public may record their suggestions which will receive the consideration of the Committee.

BREAKING A BOTTLENECK

By *Shiv S. Kapur*, Deputy Director, Railway Board.

Moghalsarai serves as a clearance centre for over 4,00c wagons a day. Coal and other traffic converges here from all directions and fans out to all sides—east, west, north, south. This inevitably makes it a variegated bottleneck, but by consistent hard work and ingenuity wagon movement here has been greatly accelerated, and on November 7, 1956, 4,535 wagons were cleared—the highest ever. New plans are in hand for further improvement.

In terms of railway geography, Moghalsarai is a natural bottleneck.

I should hasten to add that the term 'bottleneck' is used here only in its literal sense and without the empirical odium that has, legitimately perhaps, come to attach itself to the term in the recent past. Also, when I refer to it as a natural bottleneck I do not thereby start from an *a priori* position of apologising for an unpleasant fact with which one has to ultimately come to terms. There is that too, of course, the ultimate limitation beyond which physical factors alone would not permit any appreciable increase in output, but that is not yet.

This is merely the sketch of an effort at redefining that limit. The new definition of the bottleneck at Moghalsarai is wider. It is also more truly pragmatic because it has been arrived at after strenuous endeavour which, in the process, has largely discounted psychological limitations. That perhaps is the measure of the recent achievement at Moghalsarai.

A glance at any railway map would indicate the railway topography of Moghalsarai and the areas that surround it. The interests served by traffic passing through Moghalsarai, their variety, extent, and importance to the economy of the country need to be emphasized.

TRAFFIC THROUGH MOGHALSARAI

On the east, there are the coalfields, the industrial area including the locomotive works, fertilizers factory and the steel plants. There is also Calcutta port. To the west and south-west of Moghalsarai there is a vast area in need of coal, industries near Ahmedabad, those at Amritsar, Delhi, Kanpur and so many other places. They, and the railway loco. sheds themselves, all of them need coal, regularly and to their full requirement.

That is why something like 1500 wagons of coal alone pass through Moghalsarai yard every day, a vital stream from the coalfields whose flow must not be interrupted. What is more, these demands of expanding industry are daily increasing and must be met. A failure or a shortfall here would mean loss in production, a possible curtailment of railway services in the areas concerned, even as far afield as the Chola Power House near Bombay, or West Pakistan which gets its quota of coal from India every day.

The rest of the traffic passing west through Moghalsarai, approximately 500 wagons daily, is an assortment. It may include imported foodgrains or structural goods and machinery, fertilisers from the factory at Sindri, or locomotives, broad and metre gauge, for areas and railway regions in Uttar Pradesh, Delhi, Punjab, Himachal Pradesh, Rajasthan, parts of Bombay and Madhya Pradesh.

All this movement needs wagons. There is a variety of traffic that moves east, in the reverse direction, through Moghalsarai. It includes gypsum for the fertiliser factory, lime from Madhya Pradesh for the sugar factories, and jute. In addition, there are a number of empty wagons, 1200 to 1300 daily, sometimes even more, that must every day move in to feed the coal belt and the industrial area. Coal and machinery cannot move unless there is something to load them in.

That is why Moghalsarai is important: supplies fan out from here in so many directions, the return flow being gathered in here and passed on for fresh loading. It is here the many streams of movement meet; to that extent it may correctly be called a bottleneck.

A WAGON EVERY 20 SECONDS

On November 7, 4,535 wagons were despatched from Moghalsarai in both directions—an average of a wagon

despatched every 20 seconds round the clock. The empties went east, coal and other loads moved west, at least from Moghalsarai. It was the highest figure ever recorded here.

All these wagons did not come into Moghalsarai yard unannounced, nor leave quietly with no plan or forewarning. Moghalsarai has an orbit of control that is very extensive. The Central Control at Moghalsarai, functioning under a Deputy Director of the Railway Board, must remain in constant touch with detailed movement in that area. The volume and, quite often the nature, of all that is coming in from various directions must be known in advance. Further despatches must be planned and co-ordinated with the receiving sections. An upset in one direction may put the entire massive machinery out of gear. Hence the need for close and continuing regulation of incoming and outgoing movement, to anticipate the former and plan the latter.

Moghalsarai yard itself is, naturally, important. The handling every day of over 4,000 wagons in a yard with a rated capacity of 3,000 needs special effort. Receiving lines on both sides have to be kept clear, sorting of wagons over the hump has to be fast and safe, the departure yards must in accordance with the total plan of despatch in so many directions, and with loads properly marshalled so that they can run through to the farthest possible point without further handling en route, the hundreds of engine movements through the yard have to be co-ordinated.

A failure of apparatus or men here may spell temporary disaster. Most of the loaded wagons are received on so many trains, at all times, for so many various directions. Each one of some 1,800 to 1,900 wagons has to be sorted out, put on its proper train and sent on to a planned programme. Some 150 goods trains come into Moghalsarai daily or leave for their destinations. In addition there are the passenger trains.

A RECORD OF PROGRESS

A good deal thus depends upon the men working at Moghalsarai. The recent drive to increase despatches through Moghalsarai took that fact as its starting point. More potent than even the limitations imposed by the inert facilities available is the self-limitation that rules the minds of men. In paralyses endeavour mainly because the achievements and traditions of the past are allowed too large a meaning. The success achieved in getting rid of that inhibition is reflected in the following comparative figures of traffic moved through Moghalsarai in the last five years.

Year	Average daily despatches UP	DOWN
1952	1440	1423
1953	1490	1437
1954	1537	1488
1955	1672	1583
1956 (Upto July)	1787	1698
1956 —August	2020	1963

To obtain an increase of 40 per cent in daily average despatches of up traffic through Moghalsarai, a number of factors have been employed.

There has been some increase in the facilities available at Moghalsarai and on Northern and Eastern Railway sections above and below it which carry this traffic. Most of it, however, is the result of endeavour, in planning, regulation, and the daily labour that would not readily admit defeat. This effort continues; fresh targets have been laid down, chasing and area control organisations to more closely watch every movement are being set up at Moghalsarai and on adjoining sections.

There is a master plan to remodel the yard and introduce mechanisation using some of the most modern equipment.

In an expanding economy, breaking a transport bottleneck becomes a continuing process.

(Courtesy: Indian Railways Magazine)

RAILWAY LINE BETWEEN RUDRAPUR AND NAUTANWA

ENGINEERING AND TRAFFIC SURVEY TO BE MADE

The Railway Board has sanctioned a reconnaissance engineering and traffic survey for a metre gauge line between Rudrapur and Nautanwa, a distance of about 90 miles, on the North Eastern Railway.

The proposed route passes Kasia, the birth place of Buddha, and a pilgrimage spot for pilgrim from all over the world.

IN YOUR OWN INTERESTS

HOW TO PURCHASE TICKETS

Buy your tickets only at the proper place. The authorised offices are (i) the Booking offices at the railway stations, (ii) the Town or City Booking Offices, (iii) the out-Agencies, (iv) Travel Agents. Never buy tickets from any other source as that may lead you to trouble. Please note that tickets are not transferable.

Buy your tickets in the proper time. You can avoid unnecessary excitement and trouble if you come to the station in good time, that is at least half an hour before the scheduled departure of your train. The Time Tables of the Railway are on sale at Booking Offices and Bookstalls.

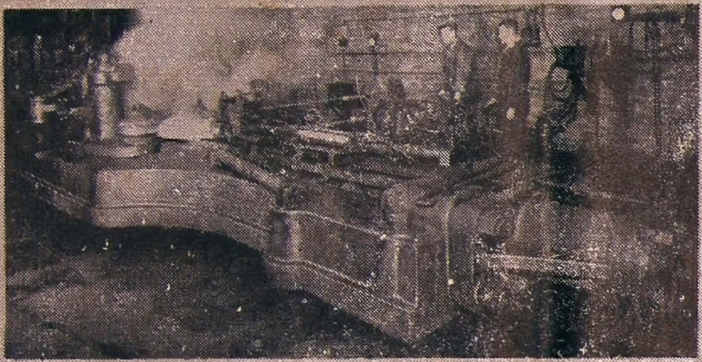
Buy your tickets in the proper manner. Queue up at the Booking Window and you can get your ticket easier and quicker than by crowding at the counter.

By handing in the *exact fare in good coins or currency* you get the ticket easier and quicker, and save for yourself and the Booking Clerk time and trouble.

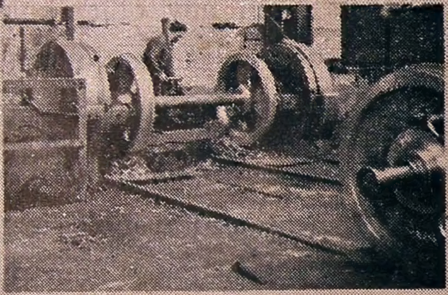
Check up your ticket and money before leaving the counter and draw the attention of the Booking Clerk to any discrepancy you may notice.

(Inserted in the interests of Travelling Public)

marking the track of India's progress



Railway wheels
tyres and axles for
the Indian railways



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